PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Combined Flotation and Clarification Device

We, DORR-OLIVER INCORPORATED, a corporation organized and existing under the laws of the State of Delaware, United States of America, of Barry Place, Stamford, Connecticut, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a combined flotation and clarification device for effecting the flotation and settlement of liquid-borne impurities.

The present invention provides as a single unit a combined device for the flotation and settlement of liquid-borne impurities, wherein flotation is achieved through the application of sub-atmospheric pressure to a portion of the over-all body of liquid in the clarification or settling basin of the device.

One object of the invention is to achieve a direct transition from a zone of flotation to a zone of settlement in a uniform and non-roiling manner, and also to provide means whereby the dissipation of the initial kinetic energy of the influent stream to a settling device may be enhanced through the provision of increased feedwell volume without the need for extending the feedwell downwardly or laterally.

The above and other objects are achieved, according to the teachings of this invention, by providing, in functional relationship to the influent to the unit, a vacuum chamber in direct hydraulic communication with the main body of liquid contained in the unit and adapted to maintain liquid therein at a mean elevation higher than that of the liquid body in the remainder of the unit. More particularly, this invention is predicated on the provision of a hollow dome-shaped vessel open at the bottom and closed at the top and sides and mounted in, or made integral with, a settling device in such a manner that the lower extremity of the said dome is at all times immersed in the main body of liquid contained in the settling device. Means, such for example as a suction pump, are provided for producing sub-atmospheric conditions within the upper portion of said dome and for initially introducing all new liquid to be treated by the device, into the zone laterally enclosed by the dome. As a result of all of these provisions an apparatus is evolved wherein a liquid bearing floatable and settleable materials is introduced into a zone of low pressure wherein and whereby bubble formation is induced or enhanced and flotation of impurities facilitated. Following this, the liquid is displaced downwardly through the hollow chamber and passes thence, by way of the open bottom thereof, directly into a second zone wherein, under quiescent conditions, settlement of heavier solids takes place. In practice, the operation is continuous with means being provided for discharging treated effluent, floated materials, and settled materials.

In its fullest embodiment, the invention contemplates the employment of the combined flotation and clarification device for the treatment of feed liquid which has already been subjected to aeration treatment. In that respect it will be appreciated that the entrained air in the liquid entering the flotation compartment increases the flotation tendency of the floatable particles and that, in combination with the effect of the reduced pressure in the upper part of the flotation compartment, produces rapid upward displacement of the floatable particles and, indeed, can result in the floatation of particles which, in the absence of prior aeration, would not be regarded as normally floatable.

In order that it may be clearly understood and more readily carried into effect, the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic cross-sectional elevation of radial flow apparatus incorporating the teachings of this invention.

Figure 2 is a schematic cross-sectional elevation of longitudinal flow apparatus incorporating the teachings of this invention.

The apparatus of Figure 1 illustrates the application of the teachings of this invention to a settling device wherein the passage of liquid during the course of settlement is in a radially outward direction to treated liquid discharge means functionally and physically remote from a generally centrally disposed influent means. Thus, marginal wall 10, which is preferably circular in horizontal cross-section but may, particularly where an existing basin is modified to incorporate the teachings of this invention, be rectangular, together with bottom 11 forms a basin to contain a main body of liquid 12. The proportions of this basin are such that relatively quiescent conditions are maintained within said main liquid body whereby solid impurities are permitted to settle therefrom and deposit on the bottom 11 to form sludge. Vacuum dome 15 is centrally disposed within the basin and is, by way of its open bottom, in direct hydraulic communication with the main liquid body. Vacuum pump 32 and vacuum line 31 comprise means for generating sub-atmospheric pressures in the upper portion of dome 15 whereby a secondary liquid body 16 is retained within the dome at a surface elevation substantially above that of the surface of the main liquid body 12, the latter elevation being established in the embodiment shown, by the elevation of the overflow edge of effluent launder 33. Influent conduit 13 and riser 14 comprise raw liquid feed means adapted to discharge directly into the region laterally encompassed by the dome 15. Effluent liquid having been exposed to treatment within the dome and basin, discharges into launder 33, and passes thence to use, further treatment or disposal by way of conduit 34. It may be observed that launder 33 comprises the sole liquid take-off means required by the unit, the need for submerged ports or orifices present in the usual vacuum flotation device having be effectively eliminated. By reason of the fact that the launder is disposed at or near the surface of the main liquid body undergoing treatment by settling, it is open to visual inspection and can readily be cleaned or otherwise serviced. This highly advantageous feature comprises one of the important elements of this invention.

A rotating scum collector, actuated by torque shaft 30 and comprising arms 23 with skimmer blades 24, is shown disposed within the vacuum chamber, said skimmer blades being in contact with the surface of the liquid body contained therein. In the course of their rotary movement blades 24 act to impel floating scum into trough 25, whence it passes, by way of conduit 26 into scum chamber 27; said scum chamber being, in turn, equipped with discharge pipe 28 with valve 29. Scum chamber 27, is of course, maintained at substantially the same pressure as that prevailing over liquid body 16 within dome 15.

Rotating sludge collecting means, comprising arms 17 and scraper blades 18, are also shown. Actuated directly by rotating riser 14 and indirectly by torque shaft 30, this assembly acts to transport settled solids or sludge to a generally centrally disposed sludge sump 19. It should be noted, however, that by the simple expedient of changing the angle of the blades 18, with or without a reversal of the slope of the bottom of the basin, the sludge collecting means could also be readily adapted to rake away from the axis of the unit to a non-central sludge sump. Sludge thickening blades such as shown at 22 are preferably provided to increase the density of the sludge prior to discharge by way of conduit 20 with valve 21.

The apparatus of Figure 1 is intended for continuous operation. Raw liquid entering by way of conduit 13 passes upwardly through rises 14 and enters the liquid body 16 at a level proximate the surface thereof. That portion of the liquid body 16 which lies above the surface elevation of the main liquid body 12 is, of course, under sub-atmospheric pressure, pressures being at a minimum at the surface of liquid body 16. Consequently, the flotation inducing effect of the vacuum is at a maximum in the region prescribed for the introduction of raw feed and, if floatable material is contained therein, there will be a strong tendency for this material to be retained at the surface of liquid body 16 in the form of scum composed of floatable solids and/or liquids together, in most cases, with entrained gas. This scum is collected by the rotating skimming assembly comprised of arms 23 with skimmer blades 24, and discharged into scum trough 25. Although scum can be pumped directly from this scum trough, it is preferred that a separate, readily accessible scum chamber such as at 27 be provided for receiving scum trough contents, by way of a connecting conduit such as at 26.

The movement of the liquid within dome 15 or, namely that of liquid body 16, is generally downward. It has been stated hereinabove, that one of the objects of this invention is to provide means for adequately dissipating the kinetic energy of the influent flow to a settling device, thereby to improve the functional efficiency of the latter. Figure 1 clearly shows how this desirable effect may be achieved without the need for baffling, encroachment on settling area, mechanical energy absorbers, or any of the other means proposed heretofore. As indicated by the wavy flow lines lying below the radial flow near the surface, the liquid commencing its

downward movement through dome 15 is likely to be quite turbulent with numerous eddies and velocity differentials. By reason of the relatively large volume of the liquid body 16, induced by the raising of the surface thereof through the application of vacuum thereto, the natural damping effect of internal shear is given an opportunity to equalize the flow and substantially eliminate turbulences. By the time the stream reaches the open bottom of dome 15, and enters into the main body of liquid 12, there is substantially uniform velocity distribution over its entire cross-section and disturbance of settlement within main liquid body 12 is minimized.

After having entered the main body of liquid 12, the flow moves substantially radially, and under quiescent conditions, toward and into launder 33, whence it passes from the apparatus by way of conduit 34. During the course of its passage through the settling basin, settleable solids descent to bottom 11 and are transported to sump 19 by rotating rake arms 17 with blades 18. Rotating blades such as at 22 may be furnished to thicken the sludge prior to its discharge from the sump by way of conduit 20 with valve 21.

The Figure 2 embodiment is similar to that of Figure 1 in all fundamental functional aspects, differing therefrom primarily by reason of the fact that it represents an adaptation of the invention to longitudinal flow settling basins. Thus in Figure 2 marginal wall 110 and bottom 111 define a generally rectangular settling basin containing a main body of liquid 112. The proportions of this basin are such that relatively quiescent conditions are maintained within said main liquid body whereby solid impurities are permitted to settle therefrom and deposit on the bottom 111 to form sludge. Vacuum dome 115 is disposed at one end, the influent end, of the basin and is by way of its open bottom in direct hydraulic communication with the main liquid body 112 the latter elevation being established by the elevation of the overflow edge of effluent launder 133. Vacuum pump 132 and vacuum line 131 comprise means for generating sub-atmospheric pressures in the upper portion of dome 115 whereby a secondary liquid body 116 is retained within the dome at a surface elevation substantially above that of the surface of the main liquid body. Influent conduit 113 and riser 114 comprise raw liquid feed means adapted to discharge directly into the region laterally encompassed by the dome. Effluent liquid, having been exposed to treatment within the dome anl the basin, discharges into launder 133 and passes thence to use, further treatment or disposal by way of conduit 134.

A rotating scum collector, actuated by torque shaft 130 and comprising arms 123 and skimmer blades 124, is shown disposed within the vacuum chamber or dome, said skimmer blades being in contact with the surface of the liquid body contained therein. In the course of their movement, blades 124 act to discharge floating scum into trough 125, whence it passes by way of conduit 126 into scum chamber 127; said scum chamber being, in turn, equipped with discharge pipe 128 with valve 129. Scum chamber 127 is, of course, maintained at substantially the same pressure as that prevailing over liquid body 116 within dome 115.

Mechanical sludge collecting means, comprising endless belt or chain 117 and scraper blades 118 are also shown. Actuated by an external drive mechanism (not shown), this assembly acts to transport settled solids or sludge to a sludge sump 119, shown in this case as being disposed near the influent end of the basin. It should be noted that traveling bar scrapers moving cyclically from one end of the basin to the other may be used in lieu of endless belt scrapers. Sludge collected in sump 119 is removed therefrom by way of pipe 120 with valve 121.

The apparatus of Figure 2 is, of course, also intended for continuous operation.

Raw liquid entering by way of conduit 113 passes upwardly through riser 114 and enters the liquid body 116 at a level proximate the surface thereof. That portion of the liquid body 116 which lies above the surface elevation of the main liquid body 112 is, of course, under sub-atmospheric pressure, pressures being at a minimum at the surface of liquid body 116. Consequently the flotation inducing effect of the vacuum is at a maximum in the region prescribed for the introduction of raw feed and, if floatable material is contained therein, there will be a strong tendency for this material to be retained at the surface of liquid body 116 in the form of scum composed of floatable solids and/or liquid, together, in most cases, with entrained gas. The scum is collected by the rotating skimming assembly comprised of arms 123 with skimmer blades 124 and discharged into scum trough 125. Although scum can be pumped directly from this scum trough, it is preferred that a separate readily accessible scum chamber, such as at 127, be provided for receiving scum trough contents by way of a connecting conduit such as at 126.

The movement of the liquid within the dome 115, or namely that of liquid body 116, is generally downward. It has been stated hereinabove, that one of the objects of this invention is to provide means for adequately dissipating the kinetic energy of the influent flow to a settling device, and thereby to improve the functional efficiency of the latter. As was the case with the Figure 1 embodiment, the embodiment of Figure 2 clearly shows how this desirable effect may be achieved without the need for baffling, encroachment on settling

area, mechanical energy absorbers, or any of the other means proposed heretofore. The wavy flow lines lying below the radial flow lines near the surface are intended to show that the liquid commencing its downward movement through dome 115 is likely to be quite turbulent with numerous eddies and velocity differentials. By reason of the relatively large volume of the liquid body 116, induced by the raising of the surface thereof through the application of vacuum thereto, the natural damping effect of internal shear is given an opportunity to equalize the flow and substantially eliminate turbulence. By the time the stream reaches the open bottom of dome 115 and enters into the main body of liquid 112, there is substantially uniform velocity distribution over its entire cross-section and disturbances of settlement within the main liquid body 112 are minimized.

After having entered the main body of liquid 112, the liquid moves under quiescent conditions toward and into launder 133, whence it passed from the apparatus by way of conduit 134. During the course of its passage through the settling basin, settleable solids descend to bottom 111 and are transported to sump 19 by scraper blades 118.

Both forms of the invention as hereinbefore described can be operated in a very advantageous manner in conjunction with an aeration device in which the feed liquor is subjected to aerobic treatment in an aerator prior to its introduction into the flotation compartment. The invention, therefore, further comprises such a combination by which considerable operational improvement can be achieved. In that respect it will be appreciated that entrainment of air in the feed entering the vacuum dome rapidly carries to the surface of the elevated liquid level in the dome not only such particles as are normally readily floatable, but also possibly, some particles which would not be so readily floatable in the absence of aeration.

WHAT WE CLAIM IS:—

1. A combined flotation and clarification device of the type in which the feed liquid to be treated is first introduced into a flotation compartment wherein the suspended flotation materials collect on the surface of the liquid and are removed whereas the settleable suspended solids gravitate downwardly with the carrier liquid through the open bottom of the flotation compartment for dispersion and settlement in the bottom of a clarifier basin from which clarified liquid overflows, characterized by the fact that the flotation compartment is formed as a compartment extending up from below to an elevation above the overflow liquid level in the basin and is closed at the top, that an elevated liquid level is maintained in the flotation compartment by suction, and that the feed liquid enters the flotation compartment at an elevation closely subjacent said elevated liquid level for dispersion downwardly and outwardly into the lower part of the clarifier basin.

2. A device according to claim 1, further characterized by the fact that the material floated at the elevated liquid level in the flotation compartment is moved by a surface skimmer into a scum trough within the flotation compartment and is conducted therefrom through a conduit to a closed chamber wherein pressure is maintained corresponding to that in the flotation compartment.

3. A device according to either of the preceding claims, further characterized by the fact that the clarifier basin is of the radial flow type with an influent feed conduit extending coaxially upward, being driven for rotation so that a raking structure carried thereby is operated to rake solids settled on the bottom of the clarifier basin to a central sludge discharge outlet sump.

4. A device according to claim 1 or claim 2, further characterized by the fact that the clarifier basin is rectangular in horizontal cross-section and supports the flotation compartment in the region of the influent end of the basin remote from a clarified liquid overflow at the other end of the basin.

5. A device according to claim 4, further characterized by the provision of settled solids discharge mechanism in the form of a rake assembly operative to transport solids settled on the bottom of the basin to a sludge discharge outlet sump at one end of the basin.

6. A device according to claim 5, further characterized by the fact that the sludge discharge outlet sump is at the influent end of the basin.

7. A device according to any of the preceding claims, in conjunction with an aeration device wherein the feed liquid is subjected to aeration prior to its introduction into the flotation compartment.

8. The apparatus substantially as described with reference to Figure 1 of the accompanying drawings.

9. The apparatus substantially as described with reference to Figure 2 of the accompanying drawings.

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799,297 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

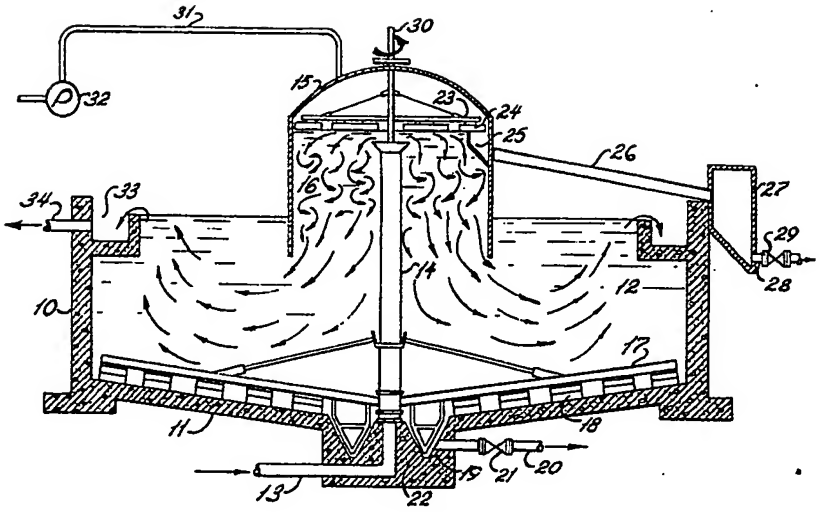

FIG. 1

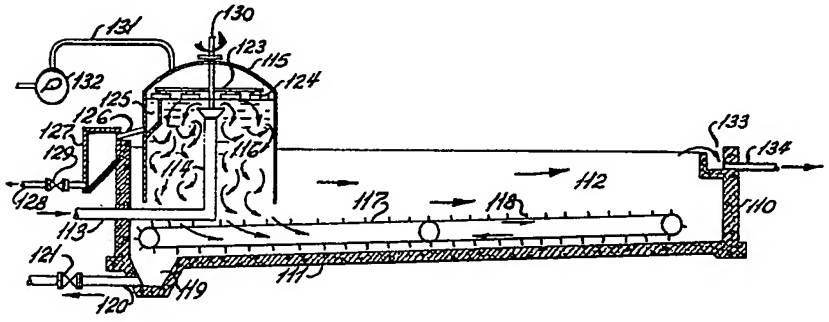

FIG. 2